REBUTTAL TESTIMONY OF

THOMAS E. HANZLIK

ON BEHALF OF

DOMINION ENERGY SOUTH CAROLINA, INC.

DOCKET NO. 2021-88-E

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND OCCUPATION.

A. My name is Thomas "Tom" Edward Hanzlik. My business address is 601 Old Taylor Road Cayce, SC 29033. I am the Manager, Electric Transmission System Operations and Control for Dominion Energy South Carolina, Inc. ("DESC").

Q. PLEASE STATE YOUR EDUCATION, BACKGROUND, AND EXPERIENCE?

A. In 1981, I graduated from Clemson University with a Bachelor of Science degree in Electrical and Computing Engineering. I am licensed in South Carolina as a Professional Engineer and a Certified System Operator with the North American Electric Reliability Corporation ("NERC"). I began my career with DESC in 1987 when I accepted a job with South Carolina Electric and Gas Company. I served in various roles during my career at DESC, including but not limited to: Manager Operations Planning, Manager Large Customer Accounts, General Manager Instel

Inc (a SCANA Subsidiary) and Power Quality Engineer. However, for the last 9 years, I have worked in my current role as the Manager, Electric Transmission System Operations and Control. Prior to working in the utility industry, I was employed by Square D Company as an Applications Engineer for industrial motor control equipment.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH CAROLINA (THE "COMMISSION")?

A. Yes, I provided testimony in DESC's prior avoided cost docket (Docket No. 2019-184-E) and DESC's Storage Tariff docket (Docket No. 2019-393-E).

Q. DID YOU PREVIOUSLY FILE DIRECT TESTIMONY WITH THE COMMISSION IN THIS PROCEEDING?

A. No.

Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?

A. The purpose of my rebuttal testimony is to provide "real-world" examples of how variable solar impacts DESC's ability to dispatch generation to meet load and comply with mandatory reliability standards. This background information is important context because it provides real-world experience that rebuts theoretical claims advanced in this docket. Specifically, I address ORS Witness Horii's testimony regarding the additional reserves needed to meet the intermittent nature of wind and solar and I rebut his aspects of his testimony regarding 1-hour ahead schedules. I also explain our very real needs for the amount of regulating reserves and contingency reserves (hereinafter referred individually and collectively to as "Operating Reserves") we carry and respond to Witness Burgess's claims regarding the levels of reserves carried by DESC and the costs to integrate variable solar. Note that the lack of a response to any of the specific assertions made by these witnesses does not necessarily constitute DESC's agreement to those assertions.

BACKGROUND REGARDING THE ROLE OF DESC'S SYSTEM CONTROL AND ITS COMPLIANCE WITH MANDATORY RELIABILITY STANDARDS

Q. CAN YOU PLEASE DESCRIBE HOW YOUR ROLE AT DESC INVOLVES BALANCING THE SYSTEM IN RESPONSE TO THESE SOLAR GENERATORS?

A. Yes. My department is located in the electric transmission system control center, in which DESC monitors and controls its transmission system, dispatches its generation fleet, and reliably meets customer load in real-time. Our primary function is to maintain compliance with regulations that govern the bulk electric system and to ensure safe and reliable electric service to our customers. Doing so requires us to plan for, anticipate, and respond to events such as changes in system load, unexpected equipment outages, generating facility trips, and other system related events to ensure reliability and minimize risk within our Balancing Authority (BA) as well as risk or impact to the Eastern Interconnection. Throughout my rebuttal testimony, I discuss the role of the BA, and the following definitions from the NERC Glossary of Terms will be helpful:

a. Balancing Authority – is a defined term for a NERC registered entity that integrates resource plans ahead of time, maintains load-interchange-generation balance within a Balancing Authority Area, and supports interconnection frequency in real time.

b. Balancing Authority Area – the collection of generation, transmission, and loads within the metered boundaries of the Balancing Authority. The Balancing Authority maintains load-resource balance within this area.

The following are key tasks a BA performs:

a. Calculate Area Control Error (ACE) within the reliability area

   i. ACE - The instantaneous difference between a Balancing Authority's net actual and scheduled interchange, taking into account the effects of Frequency Bias.

b. Operate the BA Area to maintain load-interchange-generation balance.

c. Review generation unit commitments, dispatch, and load forecasts, and direct generators as necessary to meet system requirements.

d. Formulate an operational plan (generation unit commitment, bulk power transactions, unit and line outages, etc.) for reliability evaluation.

e. Approve Arranged Interchange with neighboring BAs from a supply and ramping ability perspective.

f. Implement Confirmed Interchange transactions with neighboring BA Areas.

g. Operate the BA to contribute to Interconnection frequency.

h. Monitor and report control performance and disturbance recovery.

i. Provide balancing and energy accounting, and administer inadvertent energy paybacks.

j. Determine needs for reliability-related services.

k. Deploy reliability-related services.

l. Implement emergency procedures per internal System Operating Procedures and the NERC Standards.

Q. PLEASE EXPLAIN NERC's ROLE IN PROMOTING AND MAINTAINING THE RELIABILITY OF THE U.S. ELECTRIC GRID.

A. The 2003 blackout, which was initiated in the Midwestern United States and cascaded into Canada and the Northeastern United States, caused 50 million people to lose power. In response, Congress included requirements in the Energy Policy Act of 2005 for an independent Electric Reliability Organization (ERO). The ERO reports to FERC and is tasked with developing and enforcing mandatory reliability standards. The ERO has the authority to levy penalties over $1million per day per violation. FERC named NERC as the ERO and through delegation agreements authorized Regional Reliability Organizations (RRO) to form and monitor compliance with the NERC reliability standards. SERC was named the RRO for the Southeast and has authority to monitor DESC's compliance through regular audits and other oversight activities.

As a BA, DESC must comply with the NERC Resource and Demand Balancing (BAL) Reliability Standards. The following standards are specifically applicable to this proceeding:

Standard Number	Title	Purpose
BAL-001	Real Power Balancing Control Performance	To control Interconnection frequency within defined limits
BAL-002	Disturbance Control Standard – Contingency Reserve for Recovery from a Balancing Contingency Event	To ensure the Balancing Authority or Reserve Sharing Group (RSG) balances resources and demand and returns the BAs or RSGs Area Control Error (ACE) to defined values following a Reportable Balancing Contingency Event
BAL-003	Frequency Response and Frequency Bias Setting	To require sufficient Frequency Response from the BA to maintain Interconnection Frequency within predefined bounds by arresting frequency deviations and supporting frequency until the frequency is restored to its scheduled value. To provide consistent methods for measuring Frequency Response and determining the Frequency Bias Setting.

Compliance with these standards is mandatory and critical to ensure the reliability of DESC's BA Area and the entire Eastern Interconnection.

Q. PLEASE EXPLAIN NERC'S BAL-001 REQUIREMENT AND EXPLAIN HOW A BA'S COMPLIANCE WITH THAT RELIABILITY STANDARD IS IMPACTED BY VARIABLE GENERATION LIKE SOLAR.

A. BAL-001 is a mandatory standard that requires DESC as a BA to regulate frequency within its BAA by maintaining frequency within normal limits on a consecutive 30-minute basis. BAL-001 also requires DESC to operate to the Control Performance Standard 1 ("CPS1") calculated to be greater than or equal to 100% for each consecutive calendar 12- month period. Both requirements of BAL-001 require DESC to have Operating Reserves necessary to respond to fluctuations in frequency and ACE. Sudden drops in solar generation as well as sudden spikes in solar generation—as I describe in greater detail below—can greatly impact frequency and ACE. As a result, compliance with BAL-001 and minimizing inadvertent flow of power has become more difficult with the addition of non-dispatchable solar generation within the DESC BA.

For DESC, one of the most challenging times for our system controllers to balance the system occurs during the winter. During the winter, solar generation is completely out of sync with the winter load profile. The typical winter load curve begins with a morning peak just prior to sunrise when there is no solar output. During these early morning hours, solar is not available and DESC's non-solar generators are near maximum generation output levels while reserves are at the lowest level for the day. Almost always as the sun rises, and over the next couple of hours, system load begins to decrease, and DESC generation begins to ramp down (in economic order if possible) to lower levels to maintain a balanced system. Contrary to system needs, solar generation begins to ramp up and injects power onto our system as load is decreasing and as DESC's non-solar generation is in turn decreasing. During this time non-dispatchable solar output results in excess generation and high frequency in the DESC BA and the Eastern Interconnect. This surge in generation and resulting high frequency causes compliance issues with BAL-001 and an increase in inadvertent power flowing out of the DESC BA. The magnitude of this reliability problem and compliance problem is expected to continue to increase as the amount of solar generation increases within the DESC BA and the Eastern Interconnect.

Q. DOES DESC PLAN AND OPERATE ITS GENERATION DISPATCH AND TRANSMISSION SYSTEM IN COMPLIANCE WITH THESE RELIABILITY STANDARDS?

A. Yes. These are mandatory reliability requirements. These reliability standards were adopted because, after careful scrutiny and review during the standards adoption process, these standards were determined to enhance reliability. Additionally, DESC is routinely audited through periodic spot checks, quarterly and annual reporting, internal audits, and also more comprehensive audits that occur approximately every three years. Failure to comply with these mandatory reliability standards can result in a combination of fines, penalties, and mandatory mitigation measures imposed by SERC, NERC, or FERC.

Q. PLEASE EXPLAIN HOW DESC EVALUATES AVAILABLE GENERATION RESOURCES AND ESTABLISHES OPERATING RESERVES IN ORDER TO MEET LOAD ON A DAILY BASIS.

A. DESC develops a Balancing Integrated Operating Plan (Daily Generation Plan) twice daily as a guide for our System Operators to use when dispatching generating resources within the DESC BA. As part of this process, DESC evaluates 24 hour load forecasts against available generation in each hour to determine Operating Reserves and resource adequacy. This evaluation specifically focuses on the most critical hour of the day called the peak hour when instantaneous demand is or will be the highest in the 24-hour planning period.

The functional capabilities, ramping, voltage control, load following, and maximum output, of each available generator are considered to ensure adequate Operating Reserves can be collectively provided as needed across the peak hour of the day. All generating resources within our BA, including solar generation, are considered along with their characteristics in the development of the Balancing Integrated Operational Plan ("BIOP")and a daily reserve calculation, but not all resources have equal functionality. The BIOP allows DESC to optimize the generation assets on its system to meet expected load profiles based upon forecasted system conditions, and t functional and operating limitations of any and all generators cannot be ignored. For example, non-dispatchable solar generates when the sun and weather conditions allow it to generate. It cannot be called upon to increase its output in emergency situations—whereas gas-fired generation units have the ability to contribute to our response to such reliability events. Additionally, except for a few summer months, non-dispatchable solar generation does not support the peak demand of our BA. Therefore, dispatchable generation must be available to cover reliability events and system peaks because solar cannot functionally provide that reliability benefit.

Q. CAN YOU PLEASE EXPLAIN HOW OPERATING RESERVES RELATE TO DESC'S COMPLIANCE WITH THE BAL STANDARDS?

A. Real-time operations within the DESC BA require Operating Reserves to balance DESC's load and generation at all times and after all contingency events in order to maintain system reliability and compliance with the BAL Standards. Operating reserves are calculated daily to ensure the generating capacity is available to balance load and generation as load increases from its minimum level to the maximum peak hour of the day.

Until recently, the challenge of balancing our system in real-time has been limited to the diversity of loads (lights, hvac, electronics, appliances, manufacturing equipment, pumps, fans, etc.) and outages of traditional generators within the DESC BA. However, with the addition of solar generation and the intermittent production associated with this resource, there is a need for increased Operating Reserves specific to solar generation to maintain compliance with the BAL Standards.

Q. PLEASE EXPLAIN HOW DESC BALANCED ITS SYSTEM FROM A RELIABILITY PERSPECTIVE BEFORE THE ADDITION OF SOLAR RESOURCES.

A. Balancing the system within the DESC BA required Operating Reserves to maintain system reliability and compliance with the NERC Standards. That was true before solar and is required even more now given the significant penetration of variable solar generation on the DESC system. Prior to the addition of solar generators within the DESC BA, the reserves required to regulate were lower since the generators within the DESC BA could be dispatched and controlled.

Today, DESC still has a mix of generating resources with various operating capabilities. Nuclear and steam units have slow ramp rates (the ability to increase/decrease output) and are typically used as base load generation. Combined cycle units and pumped storage have faster ramp rates and they are used to support base load but can be held back to provide Operating Reserves. Due to environmental limitations, Saluda Hydro is limited in its ability to support load, but it can be called upon to provide contingency reserves in emergency situations. On the other hand, combustion turbines have quick start ups and fast ramp rates and are used to support system peak and to provide Operating Reserves.

Q. PLEASE EXPLAIN HOW THE ADDITION OF SOLAR GENERATION COMPLICATES THE ABILITY TO BALANCE THE SYSTEM AND COMPLY WITH MANDATORY RELIABILITY STANDARDS.

A. The addition of solar generation places a resource into the DESC BA that is variable, non-dispatchable, and uncontrolled. Adding this type of resource to the system has resulted in the need for maintaining increased levels of Operating Reserves to account for the variability. This forces DESC to rely on combined cycle plants to provide more reserves and less base load support. Given that DESC must hold these units back to supply reserves, combined cycle units cannot provide as much efficient, low-cost generation to meet energy needs on the system as would otherwise be the case. By way of example, DESC installed Automatic Generator Controls ("AGC") on a large, combined cycle plant that has previously provided generation to support base load. With the increase in solar variability, this base load plant was modified so that it is able to adjust its output more quickly and provide BAL compliance help. But when operating in AGC, some of the capacity in the plant will be utilized as Operating Reserves so that it has uncommitted capacity that can be added to the system on short notice to meet variations in generation supply or load—whether un-forecasted or forecasted. This means that the output of this highly-efficient plant will be reduced at times when it might otherwise be providing low cost service to customers. Additionally, this modification does not help the system respond to situations during light load periods when non-dispatchable solar generation results in overgeneration and puts compliance with BAL-001 at risk and increases the inadvertent power flowing out of the DESC BA.

REBUTTAL TO WITNESS HORII AND WITNESS BURGESS

Q. DO YOU AGREE WITH ORS WITNESS HORII WHEN HE STATES ON PAGE 7, LINES 5-7, THAT "INCREASING AMOUNTS OF SOLAR AND WIND GENERATION CAN REQUIRE ADDITIONAL RAMPING CAPABILITY AND RESERVES TO MEET BOTH THE INTERMITTENT NATURE OF SOLAR AND WIND?"

A. Yes. Based on what I see as manager of the DESC control room, we must have significant levels of Operating Reserves that can be operated to quickly ramp up and down to meet the fast spikes and drops in solar generation and also provide support for un-forecasted variability in solar generation.

Q. DO YOU AGREE WITH ORS WITNESS HORII WHEN HE STATES ON PAGE 8, LINES 21-22, THAT "THE RISK OF SOLAR OUTPUT BEING LOWER THAN SCHEDULED OR FORECASTED LEVELS NECESSITATES HAVING FLEXIBLE GENERATION AVAILABLE TO KEEP THE SYSTEM IN BALANCE?"

A. Yes, I agree that the risk of actual output being lower than scheduled or forecasts levels necessitates the need for flexible generation. However, I think that does not answer the question completely. From a control room perspective, DESC must maintain significant Operating Reserves to respond to variable generation, regardless of forecasting ability.

Q. CAN YOU PLEASE PROVIDE AN ACTUAL EXAMPLE OF HOW VARIABLE QF GENERATORS IMPACT DESC'S ABILITY TO COMPLY WITH THE BAL STANDARDS DISCUSSED ABOVE?

A. I have prepared graphs that visually depict the real-time variability and the corresponding real-time decisions we have to make to adjust DESC's generation to compensate for these fluctuations and maintain reliability and compliance with relevant mandatory NERC reliability standards. These graphs utilize real-world data from three days on the DESC system: (i) June 18, 2021, (ii) July 27, 2021, and (iii) July 29, 2021.

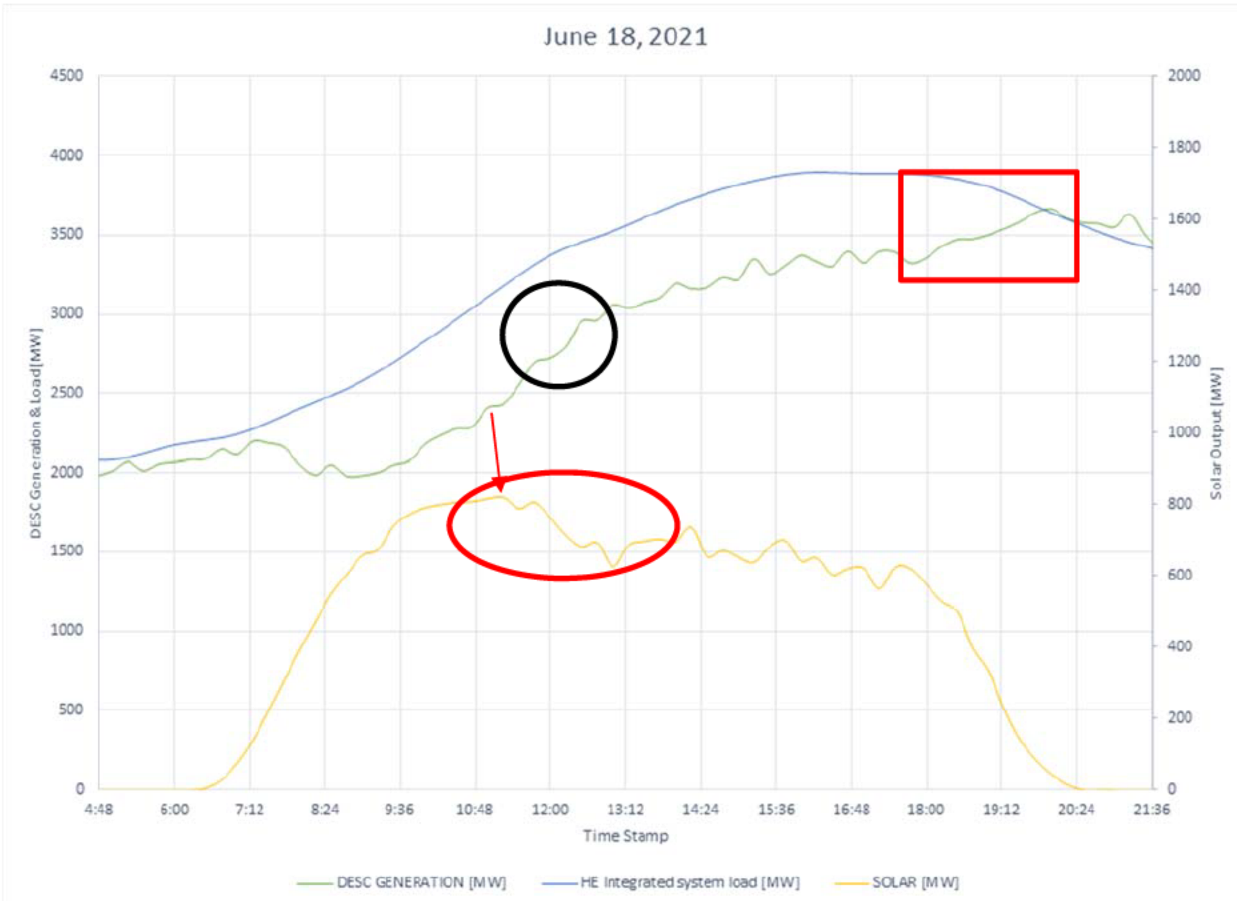
Q. CAN YOU PLEASE INTRODUCE THESE GRAPHS AT A HIGH LEVEL AND THEN PROVIDE DETAILS AS TO WHAT THEY DEPICT?

A. Yes, I can. For each day, I've provided two graphs. The first graph will take a system-wide view and illustrate DESC's generation and solar generation—as compared to DESC's load throughout that day—to highlight DESC's real-time response to the variability of solar generation. The second graph will be specific to a solar generator and will illustrate the inaccuracy of the day-ahead forecasts provided by these generators when compared to actual output on those days.

I. June 18, 2021

System-wide (June 18th)

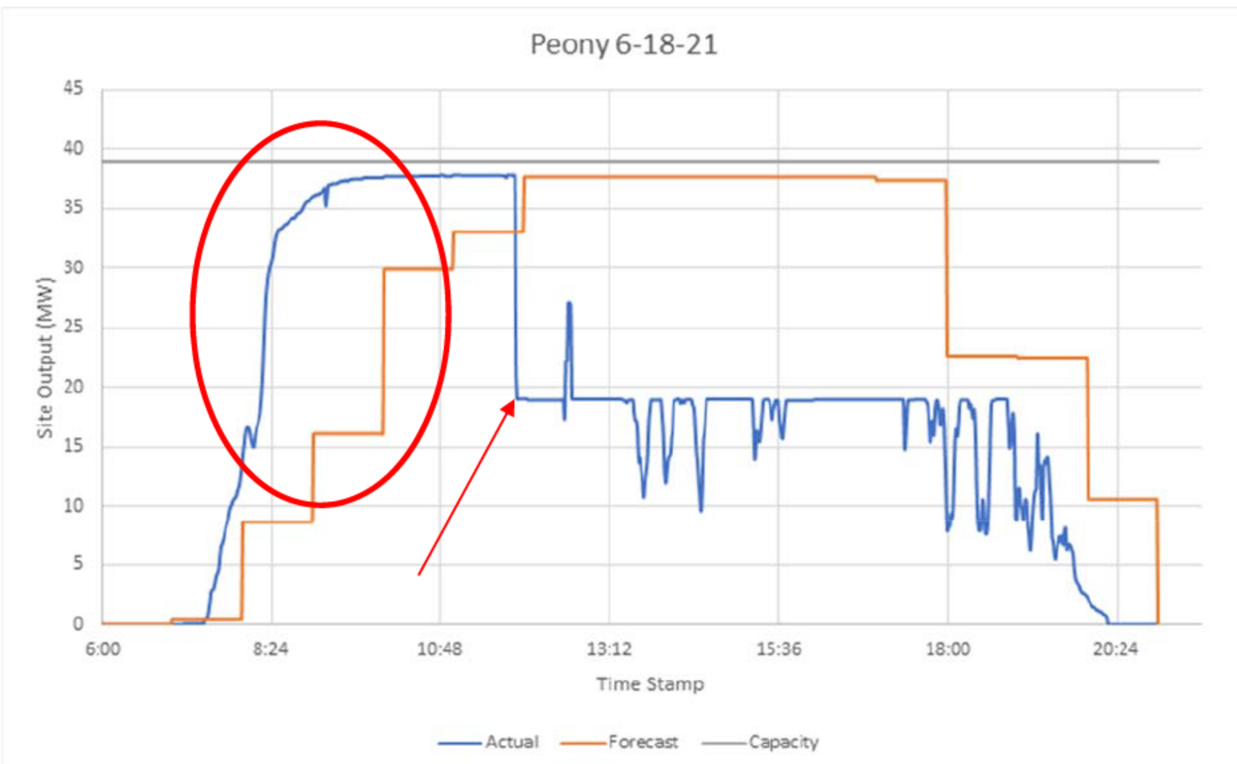
The graph below depicts a day on which DESC continued to ramp up its own generation—even when load was decreasing after the afternoon peak—to compensate for a dramatic decline in solar generation.



As indicated by the red arrow, solar peaked at 818 MW at approximately 11:00. As load continued to increase through the afternoon, solar decreased a total of 200 MW within approximately two hours, as highlighted by the red oval. In response to that dramatic decline, the black oval highlights the corresponding ramp up in DESC's own generation. DESC continued to react to the solar generation profile as it fluctuated continuously and load approached the afternoon peak. Following the afternoon peak, solar generation began to decrease at a rate faster than the decreasing rate of load. As a result—even though the system exited the afternoon peak—DESC had to once again ramp up generation to maintain system reliability, which is highlighted by the <u>red rectangle</u>. In short, the variability of solar and the high levels of penetration on the DESC system means that DESC must be ready to respond in real-time—even if it means ramping up generation as load decreases—to balance its system.

Site-specific (June 18th)

This graph yet again illustrates not only the variability of solar generation, but also the major inaccuracies of the forecasts provided by these project owners.

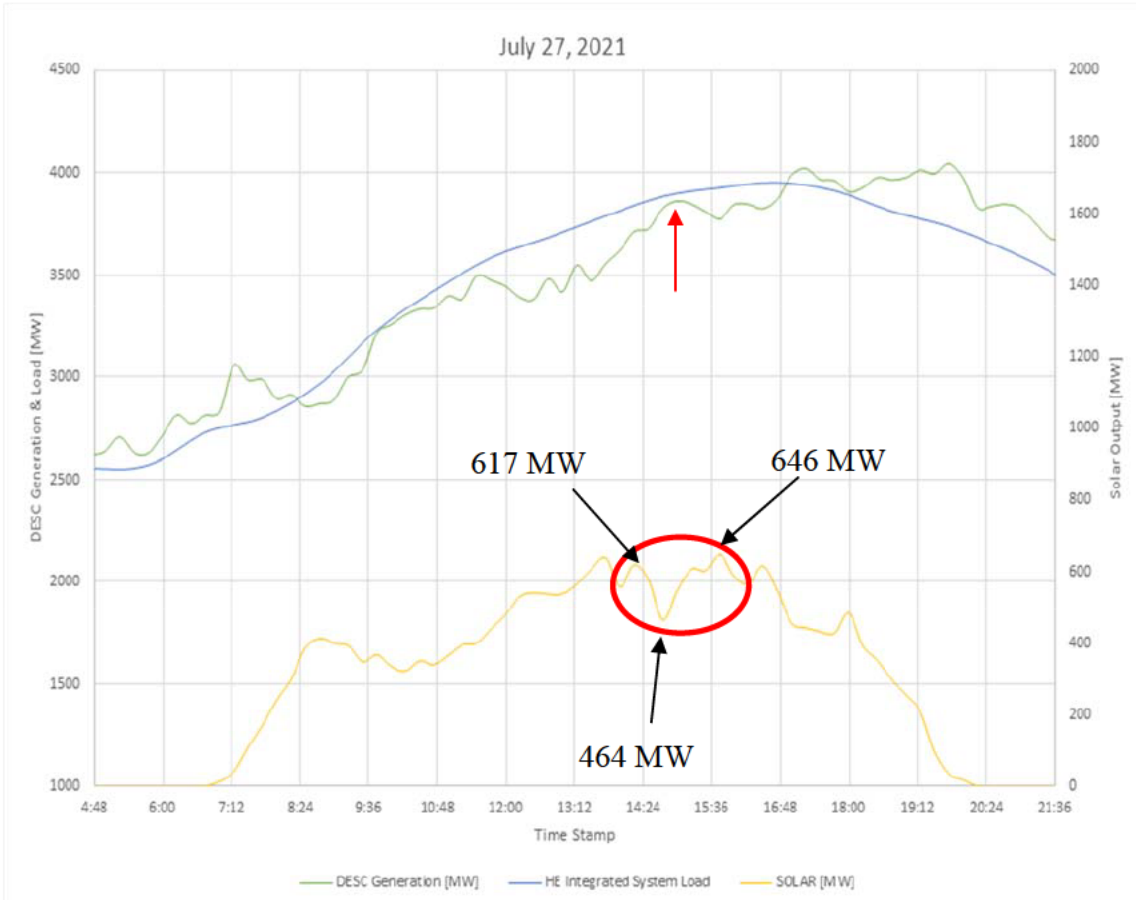


As highlighted by the <u>red oval</u>, the generation in the morning hours substantially exceeded the provided forecast. However, generation from this facility dropped approximately 50% almost instantaneously around noon, as shown by the <u>red arrow</u>. This drop resulted in generation levels that, at times, were approximately 25 MW below the forecast. These substantial inaccuracies are typical within the forecasts provided by these project owners. As such, DESC separately develops its own day-ahead forecast in the BIOP. I will illustrate how the accuracy of the BIOP compares to the forecasts provided by project owners further on in my testimony. However, although DESC's BIOP is much more accurate in forecasting solar generation, it is not 100% accurate because the intermittent, variable nature of solar generators means that their generation profile cannot be forecasted with 100% certainty. This highlights the critical need to carry increased Operating Reserves such that DESC is able to maintain the reliability of the system in real-time.

II. July 27, 2021

System-wide (July 27th)

The graph below represents a day that began as a typical summer day. However, as the day progressed, DESC saw solar generation fluctuate drastically from the forecast, including the substantial dip highlighted below by the red circle.

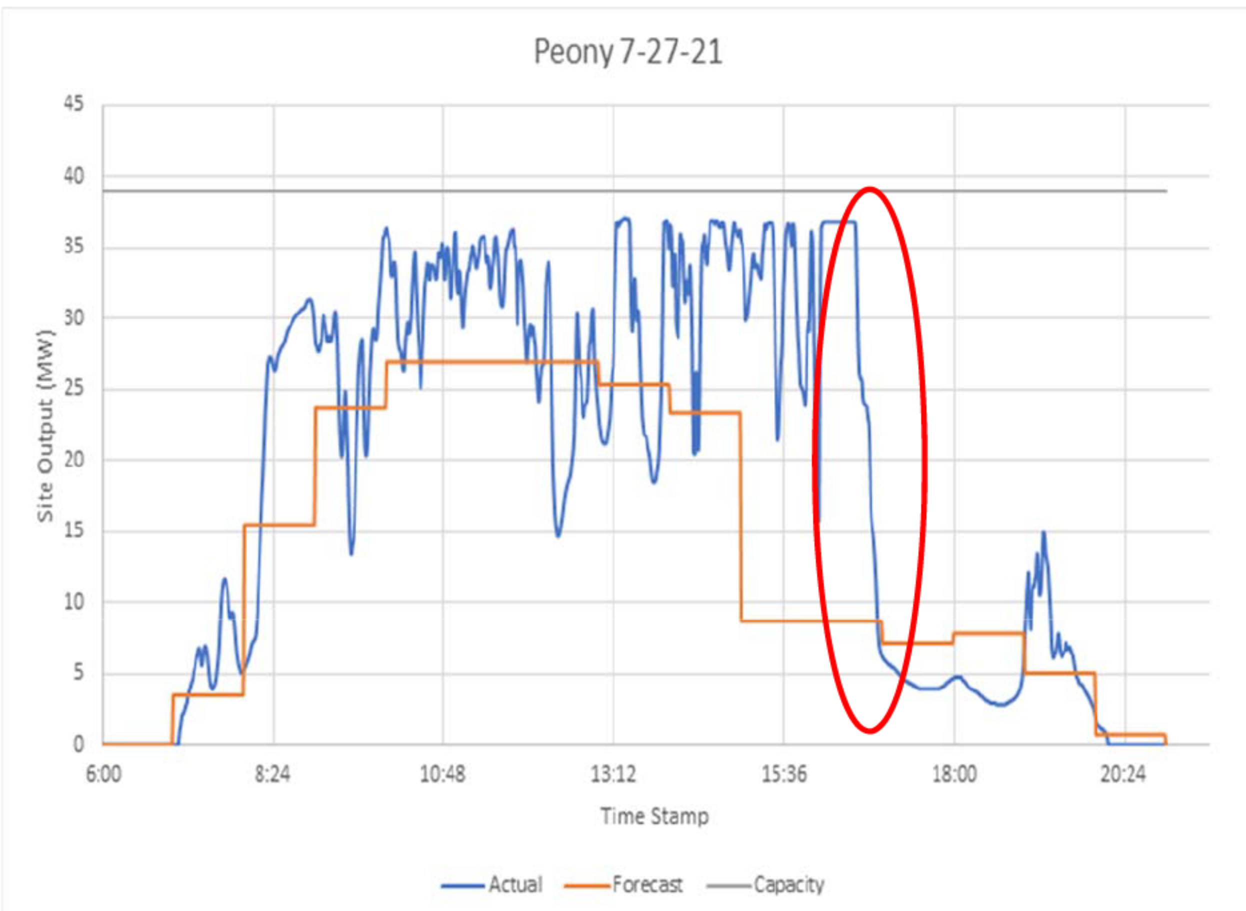


At approximately 8:30 AM solar output began decreasing and dropped approximately 90 MWs over a 90 minute period, in which it was actually forecasted to <u>increase</u> 200 MW. DESC responded by ramping available generation sooner than the BIOP indicated and began to adjust the BIOP for an afternoon with lower than forecasted solar output. As discussed above, during the period highlighted by the <u>red circle</u>, solar ramped up to approximately 617 MW around 2:00 PM, dropped to approximately 464 MW around 2:45 PM, then ramped up yet again to approximately 646 MW around 3:45 PM. During all periods, DESC had to adjust its generation fleet in real-time to account for these swings. As shown by the <u>red</u>

<u>arrow</u>, DESC had to ramp up its own generation in real-time to account for this dip, and then ramp its generation back down when solar increased. After this dip, solar then started to increase in output to a level approaching the initial forecast with a fluctuating output requiring DESC to increase Operating Reserves to follow the varying solar output.

Site-specific (July 27th)

The graph below depicts the forecast provided by a project owner for the same day (July 27, 2021) and the actual output of the plant.

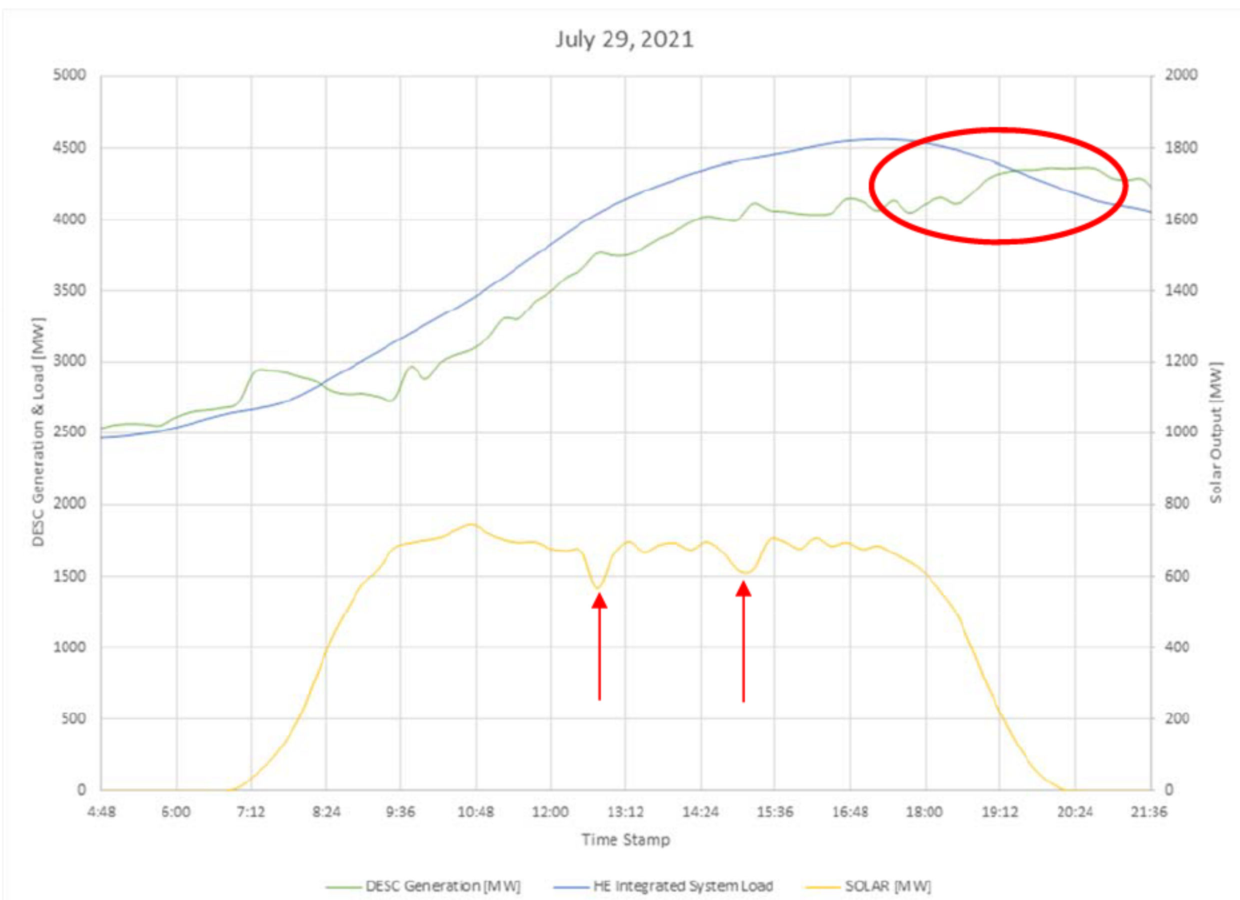


Unlike the site-specific graph provided above for Peony, on this day, Peony actually operated at a generation level for most of the day that was substantially higher than what it forecasted. However, the red oval indicates a point at which the generation dropped approximately 32 MW almost instantaneously around 4:00 PM in the afternoon. As you can see from the system-wide graph on this day, this dip at Peony occurred just as the system was entering the afternoon peak.

III. July 29, 2021

System-wide (July 29th)

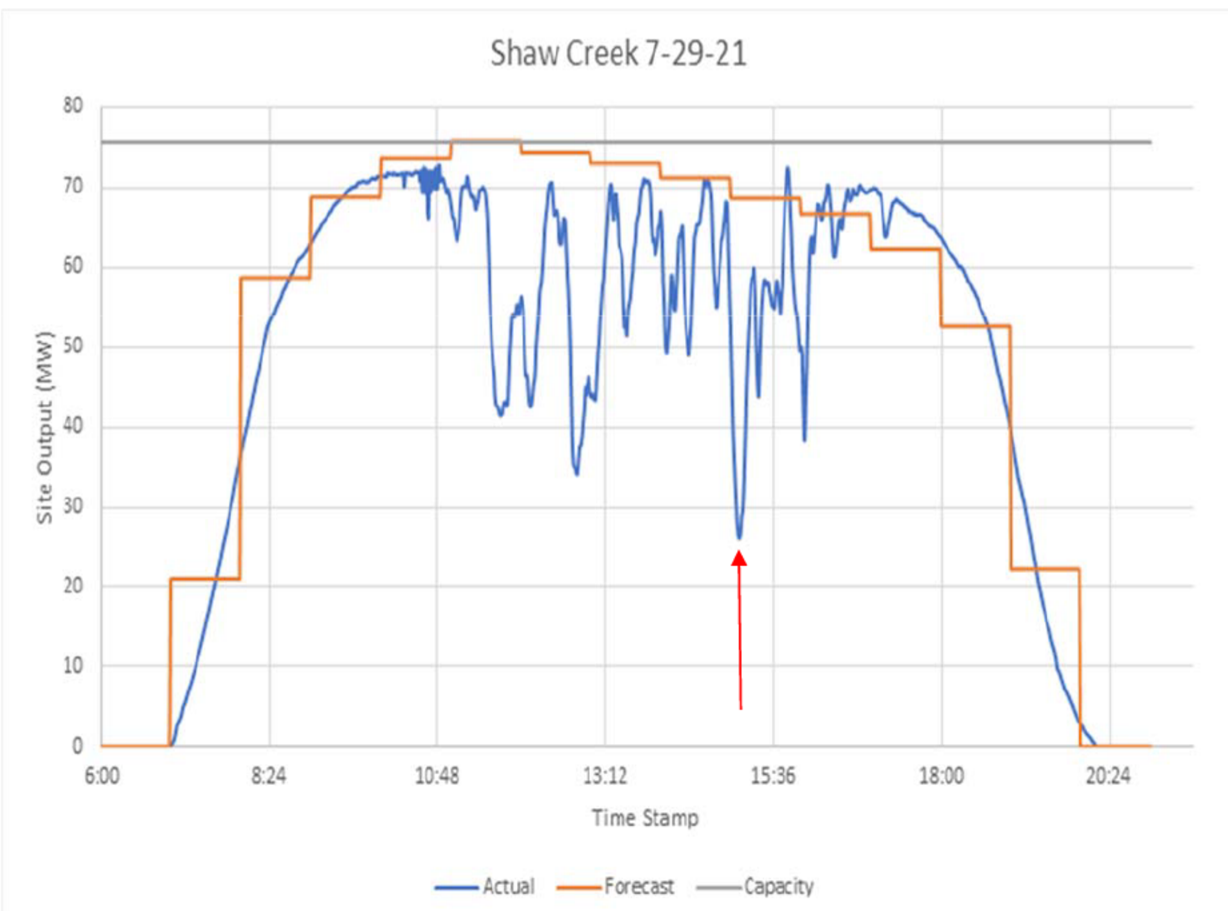
The graph below depicts a similar system profile as July 27th. However, when compared to the July 27th graph, solar generation appears to have a smoother (yet still intermittent) profile.



Even with this relatively smoother generation profile, there are still significant dips (as highlighted by the red arrows). Regardless of the generation profile, solar simply cannot maintain generation levels as the sun goes down to support the afternoon and evening peak. On this particular day, as highlighted by the red oval, load decreased off of the peak at a slower rate than solar generation, and DESC was forced to ramp up its generation to cover the difference. Here again, regardless of the solar generation profile during the day, DESC generation actually peaked during a time when solar simply could not support load.

Site-specific (July 29th)

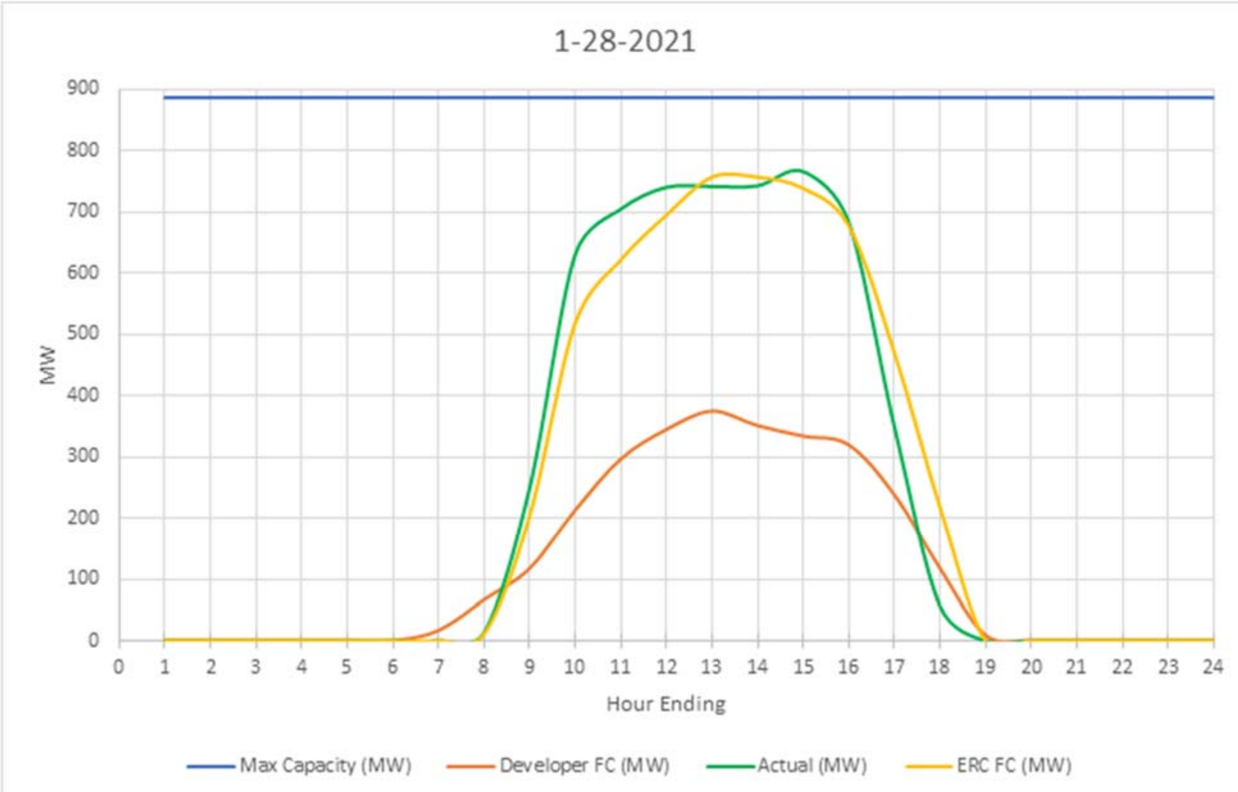
The graph below depicts a site-specific graph for that same day.



This graph is particularly helpful in pointing out how the variability at a single site contributes to the overall variability in solar generation seen on the DESC. As described by Witness David and Witness Kassis, this is the fundamental principle underlying both the VIC and the VIC Mitigation Protocols. That is, the level of variability at a single site can affect (positively or negatively) the variability seen on the overall system and the resulting need to carry Operating Reserves. As indicated by the red arrow, this plant experienced dip of approximately 40 MW almost instantaneously around 3:00 PM in the afternoon. This occurs at or about the same time as the decline in solar generation cited by the second red arrow in the system-wide graph for the same day shown above.

Q. ALTHOUGH YOU'VE PROVIDED SITE-SPECIFIC EXAMPLES OF FORECASTING, IS THE ERROR RATE LESS WHEN THE FORECASTS PROVIDED BY PROJECT OWNERS ARE AGGREGATED?

A. Not at all. In fact, relying on the aggregate forecasts can be even more problematic because not all projects submit forecasts, even though they are typically required to do so in the PPA. This is borne out by the graph below, which shows DESC's forecast and the project owners' forecasts, compared to what actually happened on this day.



Both forecasts, as well as the actual solar output, are graphed based upon hourly numbers, so the variability and error rate of the project owners' forecast would be more evident if the time periods for the actual solar output were more granular. This graph highlights the sheer absence of approximately 400 MW from the forecasts submitted. This arises from a combination of inaccurate forecasts provided by project owners, as well as project owners simply not submitting required forecasts pursuant to the PPA. As a result, DESC cannot rely on these forecasts, and DESC must plan and develop its own day-ahead forecast—which you can see is much more accurate—but still contains certain variations from what actually occurred. This speaks to the inherent difficulty in attempting to forecast, plan, and then dispatch generation when it comes to such a variable, intermittent generation resource, and why DESC must necessarily carry Operating Reserves as a result.

Q. HOW DOES THE INTERMITTENCY OF SOLAR GENERATION IMPACT THE ABILITY TO FORECAST SUCH GENERATION?

A. As discussed above, DESC generates the BIOP to aid in dispatching generation to adapt to the fluctuating, intermittent generation on the DESC system. The owners of these solar generators are also required to submit generation forecasts, but, as illustrated above, these forecasts are typically substantially different from what actually occurs on the system, which is why DESC primarily utilizes the BIOP to aid system operations. However, operating experience shows that—although DESC's BIOP provides substantially better forecasts than those provided by solar generators—it cannot be reliably predicted when solar panels will either reduce or increase their output, and therefore we must factor in the variable and significantly unpredictable operating characteristics of solar generation as a factor impacting reliability.

Q. ORS WITNESS HORII DISCUSSES 1-HOUR FORECASTS ON PAGE 9 OF HIS TESTIMONY. IF YOU HAD MORE ACCURATE FORECASTS, WOULD THAT REDUCE SYSTEM CONTROL'S NEED FOR THE AMOUNT OF RESERVES OR THE AMOUNT OF FLEXIBLE RESERVES?

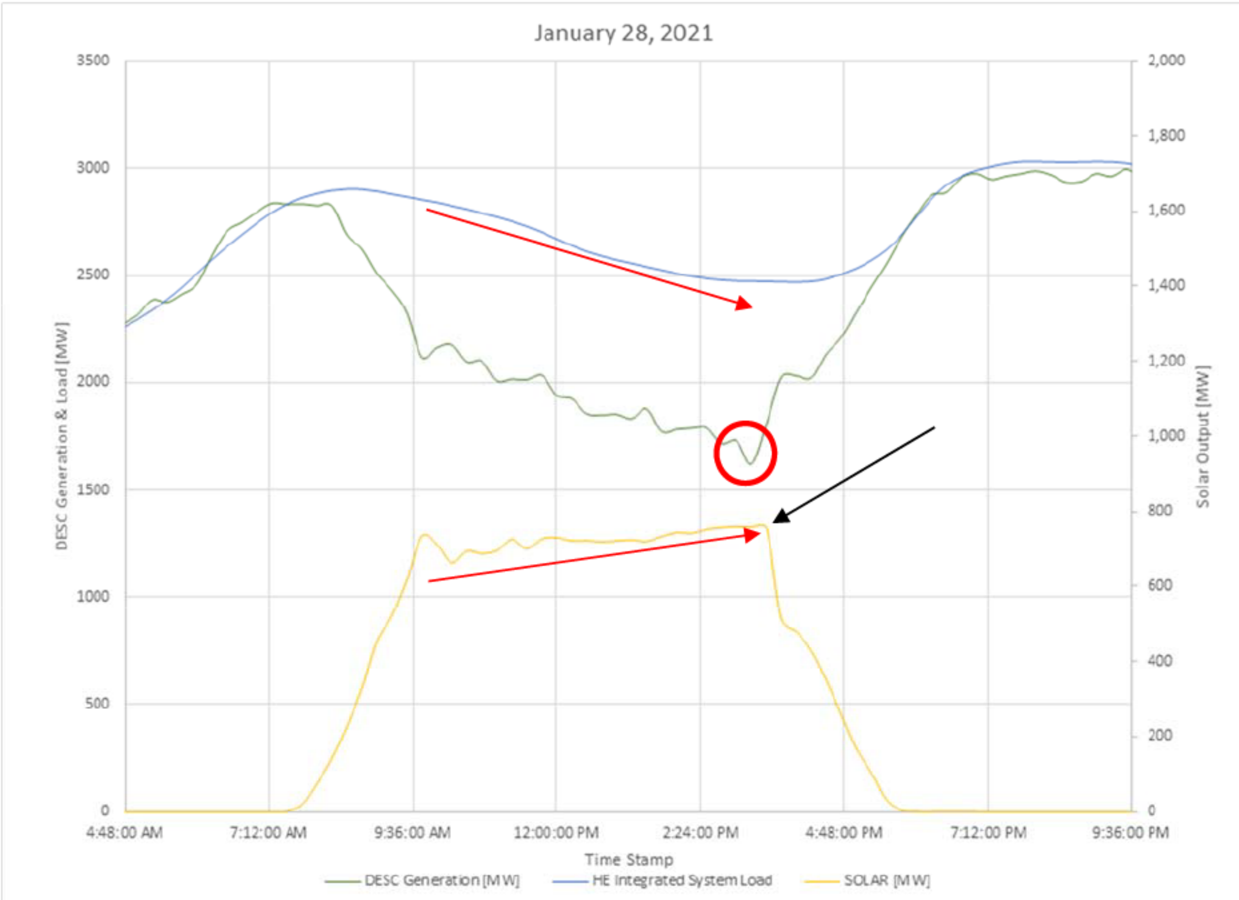
A. No. My charts above explain the actual fluctuations that occur. While it may be useful to have better forecasts from solar generators on the DESC system so we have a better idea of what to expect, we still have to be able to act. Even with more accurate forecasts, DESC would still be required to carry Operating Reserves as a result of such variability. For example, DESC must still respond to dramatic fluctuations in generator output (typically as seen in the summer season) and DESC needs significant quantities of reserves to meet peaking load when solar drops off rapidly (typically in the winter season). As QF solar penetration levels increase on the DESC system, the levels of Operating Reserves DESC must carry to respond and compensate for these real-time fluctuations (as depicted above) also increases. Likewise, the same principles can be applied to hour-ahead forecasts, meaning that the accuracy or the timeframe of the forecasts cannot eliminate the need for Operating Reserves given that the variability of solar remains in all scenarios. Additionally, even with these hour-ahead forecasts, DESC must plan Operating Reserves a day ahead for the next day's peak, not an hour ahead, which means these hour-ahead forecasts would be useless in planning for the next day's Operating Reserves.

Q. ARE THERE TIMES THROUGHOUT THE YEAR WHEN THE LOAD PROFILE AND SOLAR OUTPUT PROFILE DO NOT ALIGN?

A. Yes. This could happen anytime, but it is most easily seen during the winter season. During the winter season, there is a double peak: (i) in the morning before the sun rises and (ii) in the evening after the sun goes down. During these months, load will typically be reduced when the sun is shining during the hours of daylight between these two periods. However, the operating characteristics of solar QFs tend to be diametrically opposed, which means we will see periods where solar generation is increasing sharply—and remains high—as load is decreasing sharply and vice versa.

Q. CAN YOU PROVIDE AN ACTUAL EXAMPLE OF A DAY ON WHICH SOLAR OUTPUT AND SYSTEM LOAD DID NOT ALIGN?

A. Yes, I can. The graph below depicts just how significantly the solar penetration levels on DESC affect real-time operations—so much so that DESC implemented its curtailment protocols. Not only did DESC experience a decreasing load with increasing solar output at the same time, later in the day, DESC experienced just the opposite—a rapidly increasing load profile and drastically decreasing solar output. As a result, DESC implemented curtailment protocols in the afternoon, and utilized Operating Reserves to meet the load peak later in the very same day.



As discussed above, the inherent difficulty in forecasting solar generation can create significant consequences when operating the system in real-time. This was a typical winter day with a morning peak and an evening peak and low system loads between the two peaks. The actual solar output was slightly higher than forecasted, which corresponded with an actual load that was lower than forecasted. As you can see by the red arrows, load generally decreased as solar continued to ramp up through the morning and into the later afternoon. Given that DESC is forced to take QF solar, System Operations backed down all of DESC's generating units to their lowest reliable operating limit to accommodate the higher-than-forecasted solar generation on the system. Not only was DESC forced to back down these units, but it also had to take one turbine completely offline, resulting in a reduction of 163 MW of generation. Throughout the day, DESC was operating Fairfield Pumped Storage ("FFPS") in pumping mode by adding pumps as needed to balance the system while load continuously decreased. By approximately 3:00 PM, 6 of the 8 pumps at FFPS were operating and the level of Lake Monticello was rapidly approaching its maximum elevation of 425' which forced DESC to take pumps offline. In order to do so at 3:24 PM, DESC issued an order to curtail to four solar projects for a total of 280 MW. As the solar generators curtailed and pumps at FFPS came offline, the elevation at Lake Monticello was within .06" of reaching its maximum permitted level. Even taking these measures to back down all of DESC's generating units, utilize pumped storage, and even take a DESC generator completely offline—resulting in the decreased generation levels shown by the red circle—DESC could not accommodate the increasing output of "must-purchase" solar. At approximately 5:00 PM, the curtailment order was lifted. After the curtailment order was lifted, solar generation on the system continued to decrease as the DESC system load approached the peak hour for the day.

Q. ON PAGE 16, WITNESS BURGESS STATES THAT "THE COMMISSION SHOULD CONSIDER THE POSSIBILITY THAT INCREMENTAL COSTS FOR DESC TO INTEGRATE SOLAR IN THE RECENT PAST AND NEAR FUTURE ARE CLOSE TO ZERO." DO YOU AGREE?

A. No, I know there are actual costs. The graphs above—which depict actual data and real-world experience—make it abundantly clear the cost is not zero or anywhere close to zero. CCEBA Witness Burgess theorizes about the job we, DESC's System Control, do to accommodate variable solar. In fact, the impacts of variable generation to the DESC system are so significant that DESC is in the process of adding a renewables desk in its control room to communicate with these solar generators in the hopes of providing an exchange of information that will assist DESC in dispatching around these variable generators in real-time. This supports the testimony I have provided that demonstrates the real need for Operating Reserves based on what we experience, in real-time. The graphs I explained above are not theoretical or my studies of what we might experience. My testimony provides real insight on what we actually experience, which is critical to understand the fundamental need for Operating Reserves to respond to these variable solar generators.

CONCLUSION

Q. DOES THIS CONCLUDE YOUR PRE-FILED REBUTTAL TESTIMONY?

A. Yes.